Use of simazine and trifluralin for weed control in lupins in the Victorian Mallee

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Summary

Herbicide recommendations for the control of weeds in lupin crops in Australia are mostly based on the use of simazine. The rate used and the herbicides that are tank-mixed with simazine vary between and within States.

Investigations from 1977 to 1983 showed that in the semi-arid Victorian Mallee, weed control or lupin yields are seldom improved by applications of simazine at rates above 0.75 kg ha^{-1}. Often 0.5 kg ha^{-1} is as effective as 0.75 kg ha^{-1} and the use of trifluralin at 0.2 kg ha^{-1} with simazine at 0.5 kg ha^{-1} or above provided no additional weed control. Lupin nodulation and grain nitrogen were unaffected.

Introduction

Experiments conducted at the Mallee Research Station, Walpeup, Victoria, indicate that many farm rotations in the Victorian Mallee would benefit from the inclusion of lupins, and it is expected that the area sown to lupins will increase as more suitable cultivars and better agronomic practices are developed.

Grain lupins are grown as a cash crop, but more importantly, to raise the soil nitrogen content and to act as a break crop to control soil-borne diseases, particularly take-all (*Gaeumannomyces graminis* var. *tritici*) and cereal cyst nematode (*Heterodera avenae*). Grass weeds in the lupin crop must be controlled if this strategy is to succeed since they are alternate hosts for the pathogens.

Lupins were grown initially in the north east of Victoria where simazine is recommended at a rate of 2.0 kg ha^{-1} with the addition of trifluralin or triallate in some situations (Boundy and Reeves 1978). Similarly, in New South Wales rates of 1.5–2.0 kg ha^{-1} are recommended (Gammie and Dellow 1983). In Western Australia, however, Allen (1977) reported significant reductions in grain yield at a rate of 1.1 kg ha^{-1} on yellow sands. It was probable therefore, that a rate of 1.5 kg ha^{-1} or more could be too high for the sandy soils in the semi-arid Mallee environment.

Methods

Rates of simazine ranging up to 2 kg ha^{-1} were evaluated with and without trifluralin (0.2 kg ha^{-1}) at Walpeup.

The experiments were conducted over 6 years (1977–81 and 1983, having been deferred in 1982 owing to drought). The growing season and total rainfall for each year is shown in Table 1. Sites were prepared as winter fallows on either Walpeup sandy loam or ridge-sand soils (Newell 1960). These soils are classified by Badawy (1982) as calcareous earths Gcl.1 with a sand to clay-loam surface texture.

The herbicides were applied to the plots by a stationary spray unit supplying a 2-m hand-held boom delivering 150–200 L ha^{-1} at 140–165 kPa. The lupins (*Lupinus angustifolius* cv. Unicrop) were sown at 100 kg ha^{-1} with 200 kg ha^{-1} superphosphate within 5 h of spraying. A tyned drill was used for sowing followed by harrows to incorporate the herbicides.

Treatments were arranged in randomized blocks with four replicates and the plots were either 8 or 10 rows (175 mm spacing) × 15.5 m. The 10-row plots were reduced to 6 rows before harvest and the 8-row plots had a buffer plot between each treatment plot to reduce interactions between treatments.

Weed and crop plants were counted in two 1-m^2 quadrats per plot 7–10 weeks after sowing. The data were grouped for broadleaf weeds (*Polygonum aviculare*, *Arctotheca calen-*

Table 1 Growing-season rainfall and total rainfall at the Mallee Research Station Walpeup, Victoria

Year	Rainfall Apr.–Oct. (mm)	Annual rainfall (mm)
1977	116	201
1978	273	404
1979	234	431
1980	304	346
1981	299	380
1983	263	424
Av.: 1911–82	222	341

Table 2 Density of weeds in unsprayed plots (plants m^{-2})

Plant type	Scientific name	1977	1978	1979	1980	1981	1983	Average 1977–81, 1983
broadleaf weeds	*Polygonum aviculare* *Arctotheca calendula* *Sisymbrium orientale* *Brassica tournefortii*	145.4	42.4	0.1	120.7	42.7	28.7	63.9
grass weeds	*Lolium rigidum* *Hordeum leporinum*	1.1	23.4	0.4	5.5	36.3	10.2	12.8
medics	*Medicago* spp.	18.5	4.4	0.6	8.3	3.1	17.4	8.7
Total		165.0	70.2	1.1	134.5	82.1	56.3	85.4

dula, Sisymbrium orientale, Brassica tournefortii), grasses (*Lolium rigidum Hordeum leporinum*) and annual medics (*Medicago* spp.).

In the 1978, 1980 and 1981 sites all the lupin plants in 12 1-m lengths of row per plot, were dug up at 7–10 weeks after sowing and the roots washed. In 1978 and 1980 the percentage of plants with nodules were determined. In 1981 the plants were also classified into four categories: no nodules, crown nodules only, lateral nodules only, both crown and lateral nodules. The top growth of lupins at anthesis was measured in 1981 using the above sampling procedure and drying at 50°C for 48 h.

Lupin grain yield was obtained by harvesting with a Hege plot harvester; grain nitrogen percentage was determined by the Kjeldahl technique and adjusted to a standard moisture basis of 13.5%.

Results

The density of the main weeds present varied considerably from site to site but covered the range of weed densities typically occurring in lupin crops sown on fallow (Table 2). The low weed density in 1979 is attributed partly to the fewer crops grown on the site compared with the experiments located in other fields.

Grass weeds were significantly reduced ($P \leq 0.05$) by the application of simazine in 1980 and 1981 (Table 3). The addition of 0.20 kg ha^{-1} trifluralin did not result in significantly better control of grass weeds except at the 0.25 kg ha^{-1} simazine rate in 1980.

Simazine at rates of 0.75 kg ha^{-1} or less usually provided adequate broadleaf weed control and the addition of trifluralin resulted in no consistent, significant ($P \leq 0.05$) effect (Table 4).

Simazine rates between 0.5 and 0.75 kg ha^{-1} caused significant reductions in the medic population in 1980, 1981 and 1983, but trifluralin had no effect (Table 5). The average density of lupins was 32 plants m^{-2} (range 22–40) and there was no significant reduction in the density associated with any of the herbicide treatments.

Depending on the season, from 40 to 77% of the lupins formed nodules. Neither the percentage of plants nodulated nor the distribution of the nodules on the roots was affected by the herbicide treatments.

Application of simazine at 0.75 kg ha^{-1} increased lupin yields, except in 1977, but higher rates generally were without effect. In 1981 simazine at 2.0 kg ha^{-1} caused a reduction in the dry matter production of lupins at

Table 3 Effect of herbicides on grass weeds (plants m^{-2})

Rate (kg ha^{-1})	1977	1978	1979	1980	1981	1983
			No trifluralin + simazine			
0	1.4	12.3	0.4	3.7 (0.673)[A]	33.6 (1.539)	10.2
0.25	–	–	0.4	3.7 (0.673)	5.6 (0.817)	–
0.5	–	–	0.9	0.6 (0.119)	7.0 (0.904)	5.3
0.75	0.4	6.6	0.3	1.6 (0.430)	2.3 (0.513)	5.8
1.0	0.2	5.8	1.0	0.2 (0.075)	3.3 (0.635)	4.4
2.0	–	–	4.0	0.0 (0.000)	1.1 (0.311)	–
			0.2 trifluralin + simazine			
0	1.2	7.6	0.6	2.1 (0.484)	–	–
0.25	–	–	0.5	0.7 (0.219)	10.5 (1.062)	–
0.5	–	–	0.8	0.8 (0.251)	3.9 (0.686)	4.3
0.75	0.0	1.7	3.5	0.7 (0.239)	1.7 (0.430)	3.3
1.0	0.2	3.2	0.4	0.3 (0.119)	2.7 (0.568)	3.4
2.0	–	–	0.5	0.9 (0.288)	0.6 (0.195)	–
LSD (P = 0.05)	n.s.[B]	n.s.	n.s.	(0.367)	(0.361)	n.s.

[A] Values in parentheses are Log (x + 1) transformations.
[B] n.s, not significant.

Table 4 Effect of herbicides on broadleaf weeds (plants m^{-2})

Rate (kg ha^{-1})	1977	1978	1979	1980	1981	1983
		No trifluralim + simazine				
0	126.8 (2.106)[A]	41.8 (1.632)	0.1	126.6	33.4 (1.537)	28.7 (1.473)
0.25	–	–	3.9	24.0	9.8 (1.032)	–
0.5	–	–	1.4	9.1	1.9 (0.457)	2.0 (0.484)
0.75	91.1 (1.964)	0.4 (0.144)	3.4	11.7	1.7 (0.432)	3.5 (0.651)
1.0	23.0 (1.381)	0.4 (0.132)	10.5	27.1	0.4 (0.136)	2.0 (0.484)
2.0	–	–	8.7	0.4	0.1 (0.044)	–
		0.2 trifluralin + simazine				
0	41.0 (1.624)	33.2 (1.535)	0.1	56.5		
0.25	–	–	1.5	20.5	5.3 (0.797)	–
0.50	–	–	0.4	10.0	1.3 (0.358)	6.2 (0.856)
0.75	13.0 (1.147)	0.7 (0.239)	4.5	6.2	0.6 (0.207)	4.0 (0.697)
1.0	10.8 (1.074)	0.8 (0.263)	0.5	3.4	2.1 (0.489)	3.9 (0.688)
2.0	–	–	0.1	0.5	0.1 (0.044)	–
LSD (P = 0.05)	(0.258)	(0.294)	n.s.	36.3	(0.339)	(0.496)

[A] Values in parentheses are Log (x + 1) transformations.
[B] n.s., not significant.

Table 5 Effect of herbicides on medics (plants m^{-2})

Rate (kg ha^{-1})	1977	1978	1979	1980	1981	1983
		No trifluralin + simazine				
0	27.4 (1.453)[A]	4.4	0.7	8.1 (0.961)	3.1 (0.610)	17.4 (1.265)
0.25	–	–	0.4	5.6 (0.823)	3.0 (0.600)	–
0.5	–	–	0.3	4.1 (0.704)	1.7 (0.434)	4.2 (0.718)
0.75	19.7 (1.318)	1.6	1.1	2.7 (0.564)	0.6 (0.195)	4.0 (0.702)
1.0	7.3 (0.919)	3.0	1.0	2.6 (0.559)	0.6 (0.207)	2.5 (0.549)
2.0	–	–	0.6	0.7 (0.232)	0.1 (0.044)	–
		0.2 trifluralin + simazine				
0	15.2 (1.208)	10.7	0.9	7.2 (0.914)	–	
0.25	–	–	1.4	6.1 (0.848)	2.0 (0.477)	–
0.5	–	–	0.3	4.4 (0.729)	0.3 (0.880)	5.0 (0.781)
0.75	10.3 (1.053)	2.6	1.6	2.0 (0.473)	0.7 (0.219)	4.2 (0.718)
1.0	5.5 (0.814)	2.0	0.5	1.8 (0.443)	0.7 (0.239)	3.7 (0.669)
2.0	–	–	0.4	0.7 (0.239)	0.3 (0.119)	–
LSD (P = 0.05)	n.s.	n.s.	n.s.	(0.238)	(0.204)	(0.315)

[A] Values in parentheses are Log (x + 1) transformations.
[B] n.s., not significant.

anthesis (Table 6) and in grain yield (Table 7). Trifluralin alone resulted in significantly increased yields in 2 years out of 5 but only in 1978 did it improve upon the effect of simazine alone. Grain nitrogen content ranged between 5.2% and 5.3% and was unaffected by the herbicides in any year.

Table 6 Effects of herbicides on dry matter production of lupins at anthesis in 1981.

Rate (kg ha^{-1})	D.M. (t ha^{-1})
No trifluralin + simazine	
0	1.42
0.25	2.21
0.5	2.25
0.75	2.20
1.0	2.03
2.0	1.33
0.2 trifluralin + simazine	
0	–
0.25	2.21
0.5	2.25
0.75	1.98
1.0	2.02
2.0	1.60
LSD (P = 0.05)	0.50

Table 7 Effects of herbicides on yield of lupins (t ha^{-1})

Rate (kg ha^{-1})	Year 1977	1978	1979	1980	1981	1983
No trifluralin + simazine						
0	0.26	0.38	1.46	0.38	0.74	0.57
0.25	–	–	2.15	0.81	1.32	–
0.50	–	–	2.22	1.40	1.23	0.75
0.75	0.48	1.15	2.23	1.05	1.12	1.07
1.0	1.26	1.03	2.19	1.16	0.92	0.96
2.0	–	–	2.12	1.19	0.69	–
0.2 trifluralin + simazine						
0	1.04	0.33	1.66	0.81	1.08	–
0.25	–	–	2.29	0.79	1.05	–
0.50	–	–	2.31	1.25	1.20	0.95
0.75	0.93	1.22	2.32	1.18	1.05	0.86
1.0	1.67	1.50	2.32	1.27	1.15	1.14
2.0	–	–	2.20	1.57	1.06	–
LSD (P = 0.05)	0.66	0.28	0.23	0.50	0.30	0.28

Discussion

Cuthbertson (1976) and Reeves and Lumb (1974) reported that the yield of lupins may be doubled when simazine is used to control weeds. In the investigation reported here some yield increases also exceeded 100%, although the response was relatively insensitive to the rate applied. At higher rates, herbicide toxicity had a larger effect than the benefits from improved weed control (Gilbey 1982). This is consistent with other results (unpublished) obtained at Walpeup.

The rate of simazine likely to be toxic to lupins will depend on soil type, and toxicity has been reported with application rates of 1.1 kg ha^{-1} on yellow sands (Allen 1977) and 2.4 kg ha^{-1} on a brown clay (Cuthbertson 1976). Rates of 1.5–2.0 kg ha^{-1} used in north east Victoria (Boundy and Reeves 1978) have been shown to be unnecessarily high in the Mallee where satisfactory weed control can be achieved by rates of 0.5–0.75 kg ha^{-1} and maximum grain yields can be achieved by rates of 0.25–0.75 kg ha^{-1}. Such rates lower the cost of weed control and reduce the chance of crop toxicity. Lower rates also reduce the possibility of soil residues affecting subsequent susceptible crops (Quigley 1979). Rates up to 2.0 kg ha^{-1} did not affect plant establishment or nodulation of lupins and there were no additional benefits from applying trifluralin as well as simazine.

Acknowledgements

Financial assistance from the Wheat Industry Research Committee of Victoria is gratefully acknowledged.

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